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Research Article

Improve Ignition Quality of Gas Condensate from Khor-Mhor Fields in Cham Chamal Kurdistan Region Iraq

Barham S. Ahmed[1*], Luqman O.H. Salih[1], Baram H. Ameen[1], Muhammad M. Faraj[1], Balen D. Mahmud[1], Renas Wali Mustafa[2]

[1]Department of Chemistry, University of Sulaimani, Sulaimani, Iraq; [2]Department of Chemistry, University of Halabja, Halabja, Iraq

ABSTRACT

A gas condensate, which is produced within the production of natural gas from Khor-Mhor field, near chamchamal/Kurdistan region north of Iraq, was evaluated by determining their physical properties. Atmospheric distillation was used to produce two different boiling fractions from IBP-80°C and called straight run gasoline and 80°C-150°C named as heavy naphtha. These fractions produced directly through production of high octane rating gasoline by mixing with different additives such as oxygenates and aromatic organic solvents. The results showed that by increase of 20 vol percent of xylene anti knock index of the straight run gasoline and heavy naphtha increase by 19.75 and 19.35 points respectively.

Keywords: Gas condensate; Octane number; Oxygenate; Aromatic compound; Gasoline

INTRODUCTION

Refinery is a multiproduct manufacturing plant to produce many products such as gasoline, aviation fuel, and kerosene. Gasoline contains a complex mixture of hydrocarbon. The hydrocarbon composition with 4-12 carbons atom in their molecular structure is located in that range, and boiling points in the range of 25°C–225°C. And it is a major petroleum product in a typical petroleum refinery, roughly accounting for as much as 60%–70% of the total petroleum refinery profit. The key indication of performance property of gasoline under various engine conditions is its Octane Number (ON). Octane number is directly propotional to the gasoline resists knocking and higher ON led to the smoother the engine runs. The octane numbers improved by added additive to the gasoline. Lead compound is one of additive which was added to gasoline to boost octane ratings and reduce engine wear. This is no longer used any more due to their negative impact on the environment. However, leaded gasoline cannot be used on cars equipped with the modern catalytic converters designed to reduce harmful exhaust emissions, as lead very rapidly and permanently annihilates the performance of the catalyst. Another one of the most important additives to improve gasoline performance is oxygenates (oxygen containing organic compounds) and aromatic compound [1-5].

Blending different fuel streams which came from various production processes led to the production of gasoline, the high portion of gasoline is produced by processing the light gas condensate. The natural gas condensate is also referred to as natural gasoline, because it contains hydrocarbons compound within the gasoline boiling range, It is clear that the characteristic of mined gas condensate are significantly related with their geographical origin. Condensate is colorless or light yellow liquid, high API gravity, low density hydrocarbons, which is generally found with natural gas. The main objective of this project was preparation of premium gasoline, by blending of gas condensate from Khor Mhor gas field with alternative additives (oxygenate and aromatic) compound to enhancing octane number.

Correspondence to: Barham S. Ahmed, Department of Chemistry, University of Sulaimani, Sulaimani, Iraq, Ethiopia, E-mail: barham.sharif@univsul.edu.iq

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MATERIALS AND METHODS

Gas condensate and Material

Gas condensate were used and obtained from Khor Mhor gas field which have properties are clearly defined in the Table 5, absolute ethanol 99%, Methyl Tertiary Butyl Ether (MTBE) 99%, xylene and toluene of 99.9% purity were of analytical reagent grade and were obtained from Fluka [6-8].

Experimental procedure

Condensate from Khor Mhor gas field based on boiling range was fractionated into two major parts by using fraction distillation apparatus. First part was collected in the boiling range IBP-80°C named Straight Run Gasoline (SRG), the second one 80°C-150°C named Heavy Naphtha (HN). Then by additive method added Methyl Tertiary Butyl Ether (MTBE), ethanol, toluene and xylene by mixing volume of these additive with the volume of fractional distillates of gas condensate as shown in Tables 1-4, RON, MON, mass percent of Oxygenate (Ox), Aromatic (Ar), Saturate (Sa) and Benzene (Be) of gas condensate and the products was determined by ERASPEC fuel analyzer and total Sulfur content was determined by using a "Rigaku NEX QC energy dispersive X-ray fluorescence" according to ASTM D4294-16 (Standard test method for sulfur in petroleum and petroleum products by energy dispersive X-ray fluorescence spectrometry).

Table 1: Addition of MTBE to SRG and HN, vol% xylene and toluene: 5 ml.

No	1	2	3	4	5	6	7	8
SRG	80	75	70	65	-	-	-	-
HN	-	-	-	-	80	75	70	65
MTBE	0	5	10	15	0	5	10	15
Ethanol	10	10	10	10	10	10	10	10

Table 2: Addition of ethanol to SRG and HN, vol% xylene: 5 ml, toluene: 5 ml.

No	9	10	11	12	13	14	15	16	17	18	19	20
SRG	85	80	75	70	65	60	-	-	-	-	-	-
HN	-	-	-	-	-	-	85	80	75	70	65	60
MTBE	5	5	5	5	5	5	5	5	5	5	5	5
Ethanol	0	5	10	15	20	25	0	5	10	15	20	25

Table 3: Addition of toluene to SRG and HN, vol% xylene: 5 ml, MTBE: 5 ml.

No	21	22	23	24	25	26	27	28	29	30	31	32
SRG	80	75	70	65	60	55	-	-	-	-	-	-
HN	-	-	-	-	-	-	80	75	70	65	60	55
Toluene	0	5	10	15	20	25	0	5	10	15	20	25
Ethanol	10	10	10	10	10	10	10	10	10	10	10	10

Table 4: Addition of xylene to SRG and HN, vol% toluene: 5 ml, MTBE: 5 ml.

No	33	34	35	36	37	38	39	40	41	42	43	44
SRG	80	75	70	65	60	55	-	-	-	-	-	-
HN	-	-	-	-	-	-	80	75	70	65	60	55
Xylene	0	5	10	15	20	25	0	5	10	15	20	25
Ethanol	10	10	10	10	10	10	10	10	10	10	10	10

RESULTS AND DISCUSSION

Formulation base gasoline

Khor Mhor gas field is found in chamchamal-Sulaimani city within the Kurdistan Region of Iraq (KRI) is currently undergoing expansion to boost its production capacity and it is considered the biggest regional private sector upstream gas operation in Iraq [9-12]. The field supplies the natural gas that produces to power plants in the Chemchemal Bazian, and Erbil areas. The field moreover produces 15,000 barrels per day (bpd) of gas condensate and 1,000 Mt/d of Liquified Petroleum Gas (LPG). The values of anti-knock index, specific gravity, benzene content, sulfur content and other properties determined for Straight Run Gasoline (SRG), and Heavy Naphtha (HN) are shown in Table 5, the specific gravity of gas condensate samples is close to the specific gravity of conventional gasoline components, such as straight run gasoline or alkylate and the average value is 0.697 g/cm^3.

Table 5: Properties and composition of SRG and HN.

Fraction	SRG	HN
RON	85	79.8
MON	78	72.7
AKI	81.5	76.25
Aromatic%	2.7	8.5
Oxygenate%	0.02	0.31
Saturate%	97.3	89.9
Sp.gr 15.6°C	0.667	0.728
API	80.6	62.8
Sulfur, wt/wt%	482	574
Benzene%	0.4	0.38

The basic fuel property of gasoline for internal combustion engine is resistance to motor thump, expressed as the octane number of the gasoline. The octane (and auto ignition temperature) of different hydrocarbons is related to their capacity to resist pre fire conditions without breaking down into species that could auto ignite before the flame front arrives. The RON and MON methods use two primary reference fuels, 2,2,4 trimethyl pentane and n-heptane, assigned octane numbers of 100 and 0, respectively. The knocking intensity of the test fuel is compared to that of reference fuel mixes [13-15]. Based on the obtained results, it takes after that utilize of gas condensate as one of the mixing components of gasoline is conceivable. However, because of comparably low Anti-Knock Index (AKI) 81.5 for SRG and 76.25 for HN, using this component as a mixing component of gasoline requires amount of high octane components [16-18].

Octane enhancing additives

Oxygenated components: Octane number of SRG and HN fractions can be increased by adding antiknock additives. For this purpose, different oxygenated and aromatics compound are blended with gas condensate shown in Tables 1-4. Selective components such as MTBE, Ethanol, Toluene and Xylene were added to the Khor Mhor gas condensate in various volume percentage (0–25 vol %) and octane number is measured.

Oxygenated components, MTBE and ethanol, were used as antiknock agent to enhance octane value of gas condensate in various vol%, the effect of blending MTBE in the gasoline was evaluated. MTBE effectively boost the octane numbers of gas condensate without adversely affecting its other properties. However, MTBE is not as efficient as tetra ethyl lead compounds as far as the specific octane number improvements are concerned. The addition of 5 to 15 vol% MTBE increases 1 to 3.4 degree research octane number for SRG and HN as shown in Table 6. The addition of MTBE lowers the distillation temperature. This can improve drive ability and cold engine operation. MTBE gasoline mixture was found to be free of gums and peroxides after storage and poses no phase separation problems in the presence of water, whereas high percent of MTBE increases the volatility of gasoline. This should be prevented or minimized; therefore, a limited amount of MTBE must be used. Ethanol gasoline mixture or pure ethanol is used in many countries as a fuel to make the gasoline burn cleaner and reduce air emissions during the burning of the fuel, this fuel has a higher octane number and higher flame speeds with higher heats of vaporization than gasoline itself. Thus ethanol can be recommended as an octane booster for production of high octane gasoline. The oxygen content ratio in substance was an influence factor on RON of mixed gasoline with alcohol

components. Effect of ethanol on octane rating of SRG and HN are shown in Figures 1 and 2.

Table 6: Effect addition of MTBE on SRG and HN properties.

No	RON	MON	%Ox	%Sa	%Be
1	98	91.4	10.8	63.6	0.3
2	99	91.7	16.7	54.5	0.3
3	100.3	91.8	25.3	44.1	0.25
4	101.4	92.2	32.4	40.5	0.27
5	99	91.6	10.6	60.4	0.26
6	99.7	90.3	13.7	55	0.24
7	101.6	91.4	22.8	45.6	0.2
8	102.6	92.1	29.9	37	0.19

The results indicate that increasing ethanol concentration will increase AKI of gas condensate blends. Ethanol volume percentage in ethanol condensate blends with matched oxygen content is shown in Table 7. The higher ethanol blend, the higher the oxygen content in the gas condensate. The results show linear relationship between oxygen content and ethanol concentration. However, ethanol has some disadvantages as octane enhancer. Include its lower energy density than gasoline, lower boiling point which leads to higher evaporative emissions, miscibility with water, and toxicity to ecosystems.

Aromatic components

Aromatic compounds, in common, are the best source of fuels able to achieve highest values of octane number if they added to gasoline. Aromatic compounds have good octane ratings, more than 100, and easily convert to water and carbon dioxide after total combustion. As a result, the emissions control systems, including the catalyst and oxygen sensors, of the vehicle are not influenced. Toluene is a clear and non-polar liquid hydrocarbon with the scent of paint thinners. It is a mono substituted benzene derivative having a chemical formula of C_7H_8, The effect of increasing toluene content from 5-25% vol, in gas condensate base fuel on RON and MON gain are shown in Table 8. The results indicated that toluene has effect for increasing octane value of mixed gas condensate.

Table 7: with high energy and have Effect addition of Ethanol on SRG and HN properties.high octane ratings; thus, they are

No	RON	MON	%Ox	%Sa	%Be
9	96.1	90.1	4.94	70.3	0.37
10	96.1	90.1	11	62.1	0.33
11	98.5	89.5	15.7	58.7	0.26
12	99.7	89.3	19.9	54.7	0.25
13	105.3	95.4	23.6	50.2	0.21
14	106.2	95.7	27.5	48.1	0.24
15	96.5	90.3	5.09	65.9	0.32
16	97.5	90.1	10.4	59.4	0.29
17	99.1	90.4	17.3	53.7	0.25
18	100.5	91	19.4	52.1	0.23

19	105.2	95.4	22.6	49.6	0.2
20	107.6	96.7	27.6	45.1	0.22

Xylene is very effective aromatic additive that can upgrading the octane number of SRG and HN. Xylene as a result of its great affectability in gasoline combustion will offer higher AKI pick up. For example at xylene concentration up to 20 vol% allows increasing the AKI by 19.75 and 19.35 points, for SRG and HN respectively as shown in Figures 1 and 2. In other words, addition of this aromatic additive can improve combustion efficiency and lead to higher CO emissions in gasoline. Aromatics compound are well known for being very harmful and carcinogenic compounds.

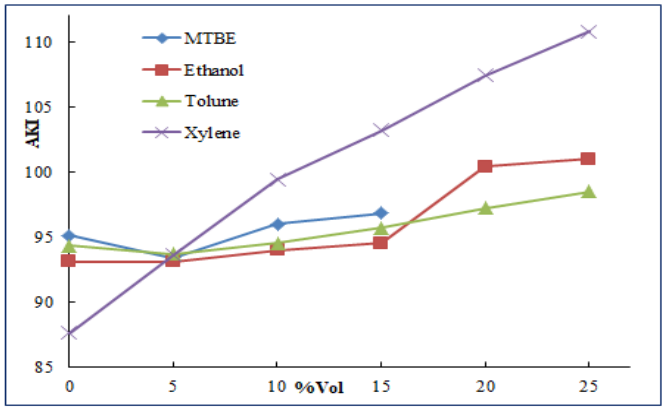

Figure 1: Effect of additive on AKI SRG.

From the results, research and motor octane numbers of all SRG and HN blends clearly increase with both oxygenates and aromatic. The results indicate that xylene is the best octane enhancer as compared with MTBE, ethanol and toluene (Table 9.

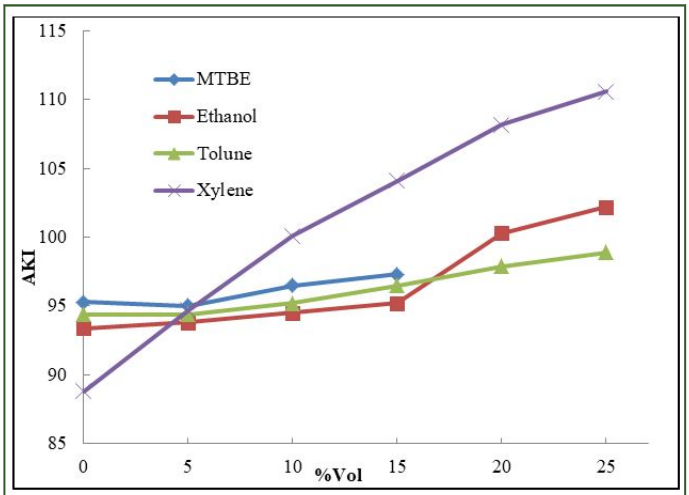

Figure 2: Effect of additive on AKI HN.

Table 8: Effect addition of toluene on SRG and HN properties.

No	RON	MON	%Ar	%Ox	%Sa	%Be
21	98.1	90.6	21.2	16.3	62.5	0.3
22	97.7	90.7	28.3	16.7	55	0.3
23	99.1	90.8	34.7	16.4	48.9	0.27
24	101.1	90.4	39.2	17.4	43.4	0.27
25	103.1	91.3	44.2	17.3	38.6	0.23
26	104.8	92.3	49.5	14.2	36.3	0.23
27	98.4	90.4	22.1	16.7	61.2	0.24
28	98.9	89.8	29.9	16.8	53.3	0.23
29	100.5	90	35.2	16.6	47.9	0.23
30	102.2	90.8	40.4	16.4	43.2	0.21
31	104.1	91.7	45.2	16.4	38.4	0.21
32	105.4	92.3	47.6	13.7	38.7	0.20

Table 9: Effect addition of xylene on SRG and HN properties.

No	RON	MON	%Ar	%Ox	%Sa	%Be
33	91.4	83.8	9.3	15.7	75	0.28
34	97.2	90	27.8	18.2	54	0.29
35	103.8	94.9	39.9	18	42.1	0.26
36	107.2	99.3	53.9	17.9	28.3	0.32
37	111.9	102.8	59.3	18	22.7	0.27
38	115.1	106.5	67	15.3	17.7	0.26
39	92.7	84.9	15.6	17	66.7	0.26
40	99.3	90	29.8	16.6	53.7	0.24
41	105.2	95.1	41.3	17.5	41.2	0.21
42	109.1	99.1	50.2	16.5	33.3	0.24
43	113.1	103.2	59.3	14.6	26.1	0.23
44	115.5	105.6	63.5	14.2	22.3	0.20

CONCLUSION

- It was found that SRG from Khor Mhor gas condensate has low sulfur content, and higher octane number than HN fraction.
- Oxygenates and aromatic compounds can be used to enhance octane number of gas condensate, however the highest RON and MON are founded when xylene were added.

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